BEAM TEST OF COLD-FORMED STEEL BUILT-UP OPEN SECTION WITH DIFFERENT NUMBER AND POSITION OF PERFORATIONS

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I/We* hereby declare that I/We* have checked this thesis/project* and in my/our* opinion, this thesis/project* is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRACT

A cold-formed steel member include such products as purlins and girts for the construction of metal buildings, studs and joists for light commercial and residential construction, supports for curtain wall systems and also as a formed deck for the construction of floors and roof. Cold-formed steel comes with various type of section based on their function and purpose in construction work. This research will investigate the failure mode regarding the buckling behavior and the ultimate load of built-up cold-formed steel members with circular web holes. Structural members of cold-formed steel usually come with the presence of perforations. Perforation is a hole or opening that is made on the cold-formed steel to ease construction work. A total of 5 specimens with 20 mm holes diameters were tested under four-point bending test. The built-up open sections were assembled by self-tapping screws from either two lipped channels. Each member has nominal thickness of 1.2 mm, beam length of 1600 mm and supported with roller at both end. Reduction of ultimate loading and localized failure due to the presence of holes in the web plates of beams was observed in the tests. The result of this experiment shows that the ultimate load of each sample varies greatly on the number and position of perforation. The result is presented in two sections which are load vs displacement and buckling behavior.

ABSTRAK

Keluli yang terbentuk sejuk termasuk produk-produk seperti purlins dan girts untuk pembinaan bangunan logam, kancing dan gelang untuk pembinaan komersial dan kediaman ringan, sokongan untuk sistem dinding tirai dan juga sebagai dek terbentuk untuk pembinaan lantai dan bumbung. Keluli terbentuk sejuk mempunyai pelbagai jenis seksyen berdasarkan fungsi dan tujuan mereka dalam kerja pembinaan. Penyelidikan ini akan menyiasat mod kegagalan mengenai tingkah laku tenggelam dan beban muktamad keluli terbentuk sejuk yang dibentuk dengan lubang web bulat. Ahli struktur keluli terbentuk sejuk biasanya datang dengan kehadiran bukaan. Pembukaan adalah lubang atau pembukaan yang dibuat pada keluli terbentuk sejuk untuk memudahkan kerja pembinaan. Sejumlah 5 spesimen dengan diameter lubang 20 mm telah diuji di bawah ujian lenturan empat titik. Bahagian terbuka terbina dipasang oleh skru menegak sendiri dari dua saluran lipped. Setiap anggota mempunyai ketebalan nominal 1.2 mm, panjang rasuk 1600 mm dan disokong dengan roller pada kedua-dua hujungnya. Pengurangan pemuatan muktamad dan kegagalan setempat disebabkan oleh kehadiran lubang di plat web balok diperhatikan dalam ujian. Hasil daripada eksperimen ini menunjukkan bahawa beban muktamad setiap sampel sangat berbeza pada bilangan dan kedudukan perforasi. Hasilnya dibentangkan dalam dua bahagian iaitu beban vs anjakan dan tingkah laku.

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CFS	Cold-Formed Steel
AISI	American Iron and Steel Institute
FE	Finite Element

CHAPTER 1

INTRODUCTION

1.1 Introduction

The use of cold-formed steel members in building construction began in about the 1850s in both the United States and Great Britain. However, such steel members were not widely used in buildings until around 1940 (Steel, 2010). The earlier editions of the specification were based largely on the research sponsored by American Iron and Steel Institute (AISI) at Cornell University under the direction of George Winter since 1939. It has been revised subsequently to reflect the technical developments and the results of continuing research. Since 1946 the use and the development of thin-walled cold-formed steel construction in the United States have been accelerated by the issuance of various editions of the ‘‘Specification for the Design of Cold-Formed Steel Structural Members’’ of the American Iron and Steel Institute (AISI) (Steel, 2010).

Cold-formed steel construction materials differ from other steel construction materials known as hot-rolled steel. The manufacturing of cold-formed steel products occurs at room temperature using rolling or pressing. The strength of elements used for design usually governed by buckling. The construction practices are more similar to timber framing using screws to assemble stud frames. Cold-formed steel is widely used in buildings, automobiles, equipment, home and office furniture, utility poles, storage racks, grain bins, highway products, drainage facilities, and bridges. Its popularity can be attributed to ease of mass production and prefabrication, uniform quality, lightweight designs, economy in transportation and handling, and quick and simple erection or installation (Steel, 2010). These types of sections are cold-formed from steel sheet, strip, plate, or flat bar in roll forming machines, by press brake (machine press) or bending operations (Steel, 2010). The material thicknesses for such thin-walled steel

members usually range from 0.373 mm to about 6.35 mm. Steel plates and bars as thick as 25.4 mm can also be cold-formed successfully into structural shapes.

A cold-formed steel member include such products as purlins and girts for the construction of metal buildings, studs and joists for light commercial and residential construction, supports for curtain wall systems and also as a formed deck for the construction of floors and roof (Steel, 2010). These products have enjoyed significant growth in recent years and frequently utilized in some shape in many projects today. Attributes such as strength, versatility, non-combustibility, and ease of production, make them cost effective in many applications. Cold formed steel has been used as the primary structure for flexural and compression member due to varieties of advantages such as high strength to weight ratio, high corrosion resistance, and ease of fabrication. The criteria need to be considered in improving the structural strength is the fabrication method. Fast and easy fabrication can produce an efficient structure. Built-up of normal cold-formed steel into new member with higher strength can be produced efficiently by attaching the normal steel using self-drilling screw (Muftah, Mohd Sani, Mohammad, & Tahir, 2014).

Cold-formed steel built-up cross-sections are commonly used in the building construction industry. Nowadays, several cross-sections can be built using standard single sections (C, U, Σ, etc.) available, including open built-up sections. Built-up cross-sections have several advantages over single sections. A built-up cross-section can span more distance, have a higher load bearing capacity and higher torsional stiffness. Moreover, the use of built-up cross-sections can be a major economic advantage since the whole manufacture process remains the same (Craveiro, Rodrigues, & Laím, 2016). There are many type of cold-formed steel shapes that used in construction. Figure 1.1 shows the various shape of cold-formed steel sections that have in building construction such as the usual shapes are channels of C-sections, Z-sections, angle and lipped channel. Moreover, C-sections and Z-sections are typically use in cold formed steel joists as shown in Figure 1.2.

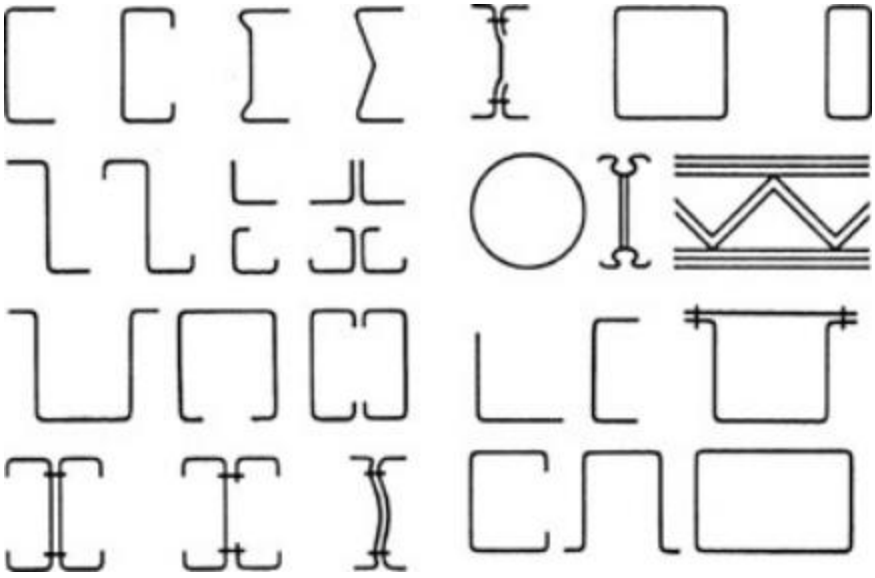

Figure 1.1 Various shape of cold-formed steel section

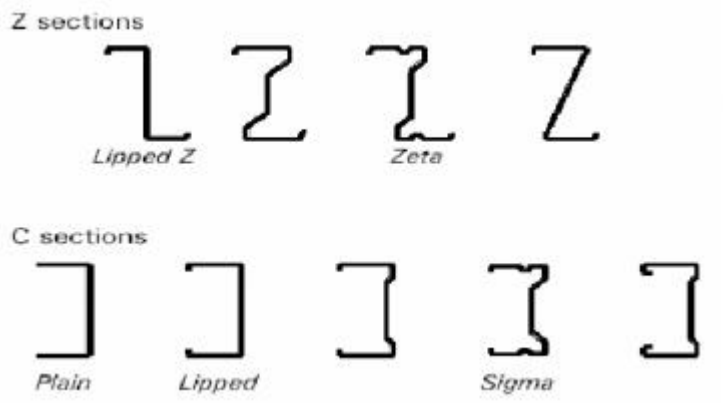

Figure 1.2 Common shapes for cold formed steel (C and Z section)

Cold-formed steel (CFS) are commonly used for floor joists and other structural members. However, these section beams are prone to fail by lateral torsional buckling due to the location of its shear center and centroid of the cross section. One way to overcome the problem is to connect two individual sections together to form double-symmetric built-up open section (Wang & Young, 2015). Besides, cold-formed steel also used as non-structural member for wall paneling, window frames, services and doorframes. As structural members, the usage includes beams, columns, truss members and roof sheeting. Figure 1.3 shows the model of beam formed with cold-formed steel section.

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